

The Scientific Investigation of the Inscription of King Ram Khamhaeng

by Chiraporn Aranyanak

A number of scholars have raised many questions concerning the authenticity of the Inscription of King Ram Khamhaeng. Some of the scholars believe this inscription could have been written in the early Bangkok period (between 1833 and 1855). For this reason, specialists in several related fields have been working very hard to investigate this inscription by various means. Scientific methods are also being used for this investigation.

The only procedure to evaluate the age of this inscription is to assess weathering characteristics. If this inscription was inscribed in the Sukhothai period, it must have been exposed outdoors for a period of several hundreds years before its transfer to Bangkok, around 1833. The chemical composition and weathering characteristics on its exposed surface should be similar to other Sukhothai inscriptions. A comparative study must be undertaken. But this should only involve the same type of stone as the Inscription of King Ram Khamhaeng. The stones used for comparison should have the same chemical composition and texture.



Inscription of King Ram Khamhaeng.

Records indicate that the Inscription of King Ram Khamhaeng has been kept indoors most of the time, since 1833. If it was really inscribed in the early Bangkok period, its weathering period is relatively negligible.

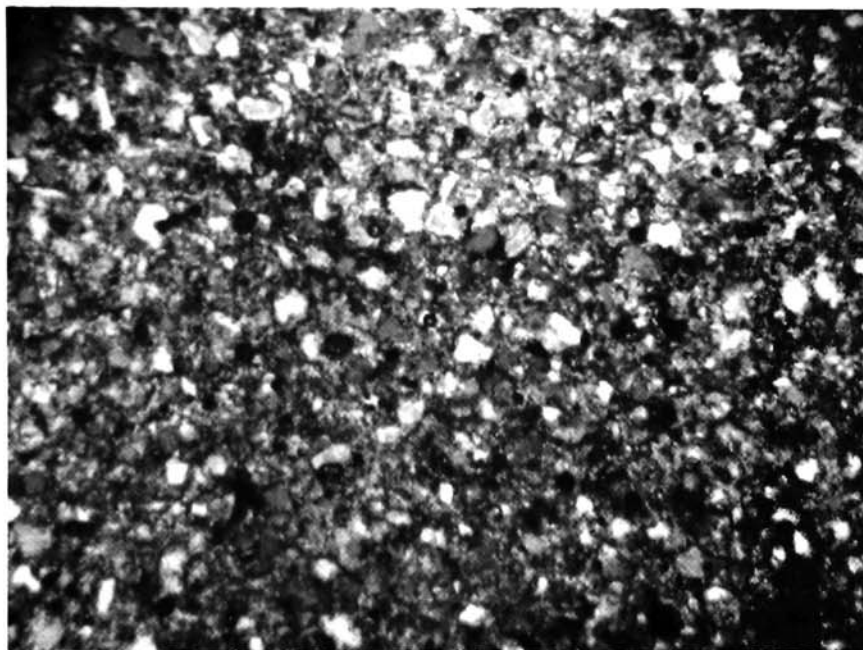
Stones directly exposed to weathering agents usually undergo much heavier damage than those protected indoors. The direct action of rain, sunlight, temperature and wind are the main destructive agents. The eroding action of wind, combined with sand or dust, can cause cavitation since dirt, dust, grits and all other such pollutants consist of solid particle sizes. With their varying degrees of hardness and chemical reactivity, they all act as agents of deterioration, either chemically or physically or both.

The main vehicles of chemical action are the atmosphere and water. They cause the etching, leaching, erosion, oxidation and dissolution of stone. Acidic gases in the atmosphere, i.e., carbon dioxide (CO_2) and sulphur dioxide (SO_2) when combined with rainwater, produce carbonic acid

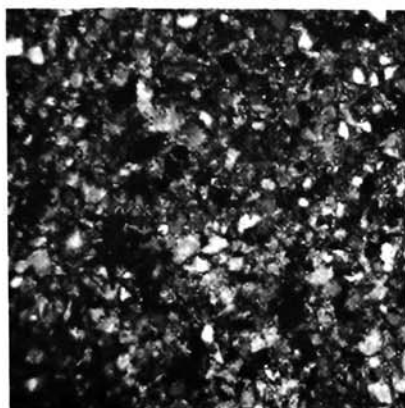
(H_2CO_3) and sulphuric acid (H_2SO_4) respectively. These acids are capable of dissolving most stones. The greatest erosion observed is on rainwashed surfaces. The resulting calcium bicarbonate ($Ca(HCO_3)_2$) and calcium sulphate ($CaSO_4 \cdot 2H_2O$) from the attack are continually washed away by rain, thus, exposing another fresh surface for a new attack.

Consequently, the exposed surface is disfigured. This is due to the alteration of the original texture by selective leaching, from the stone of one of its components, or by the etching and roughening of the polished surface.

The dominant form of deterioration in a particular area depends on the physical and chemical nature of



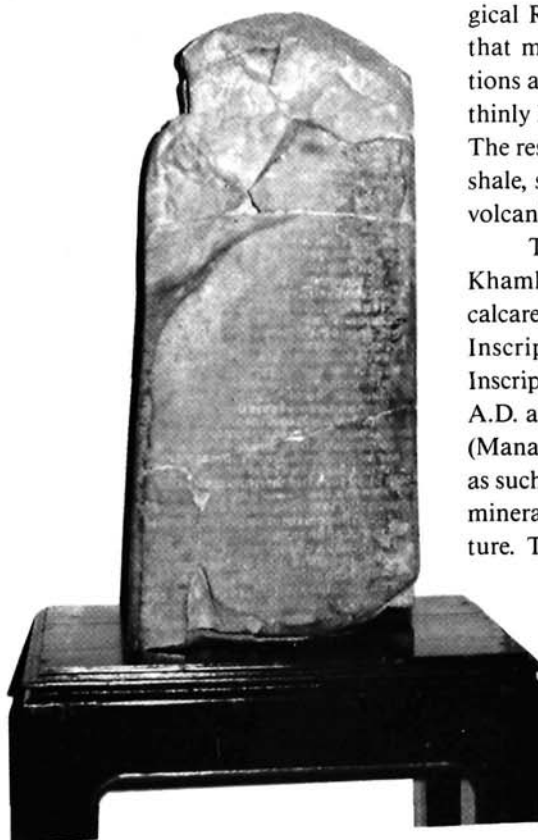
Optical micrograph of a thin section of the Inscription of King Ram Khamhaeng.



Optical micrograph of a thin section of Inscription No. 45 from Sukhothai.

the stone involved. It also depends on the kind of external or *in situ* environment in which it was subjected to.

This investigation began with surveys on the types and conditions of stone inscriptions and artifacts belonging to the Sukhothai and Bangkok periods. The mineralogical and petrographical analyses of selected inscriptions were carried out by Mrs. Srisopha Maranate. She is from



Inscription No. 45 from Sukhothai.

Thailand's Department of Mineralogical Resources. Her analyses reveal that most of the Sukhothai inscriptions and stone artifacts are phyllites, thinly laminated metamorphic rocks. The rest of the stones investigated are shale, schist, sandstone, siltstone and volcanic rocks.

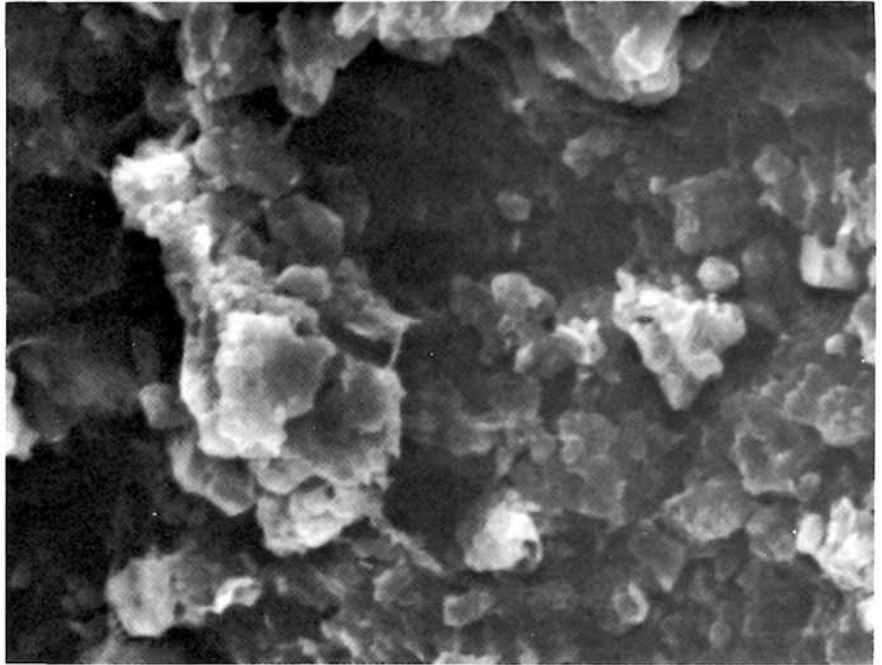
The Inscription of King Ram Khamhaeng was identified as a calcareous siltstone. Inscription No.3, Inscription No.45, the Pali-Thai Inscription belong to the 14th century A.D. and the throne from Sukhothai (Manang Silabat) are also identified as such. These specimens have similar mineralogical composition and texture. They are composed mainly of

quartz, feldspar and calcite. The minor minerals are sericite, chlorite, iron oxide and tourmaline. The main cementing material is calcite or calcium carbonate. This type of calcareous siltstone naturally occurs in Northern Thailand, i.e., Lampang, Uttaradit, Chiang Rai, Mae Hong Son, and Sukhothai.

The inscriptions and stone artifacts belonging to the early Bangkok Period are mostly limestone, granite, shale, slate, marble, sandstone, tuff and diorite. None of them is calcareous siltstone.

Examination by magnifying lenses and ultra-violet radiation indicates that the Inscription of King Ram Khamhaeng has been extensively exposed outdoors. The inscription's exposed surface has been eroded to a certain extent.

Examination by scanning electron microscope reveals that the weathering characteristics of the exposed surface of the Inscription of

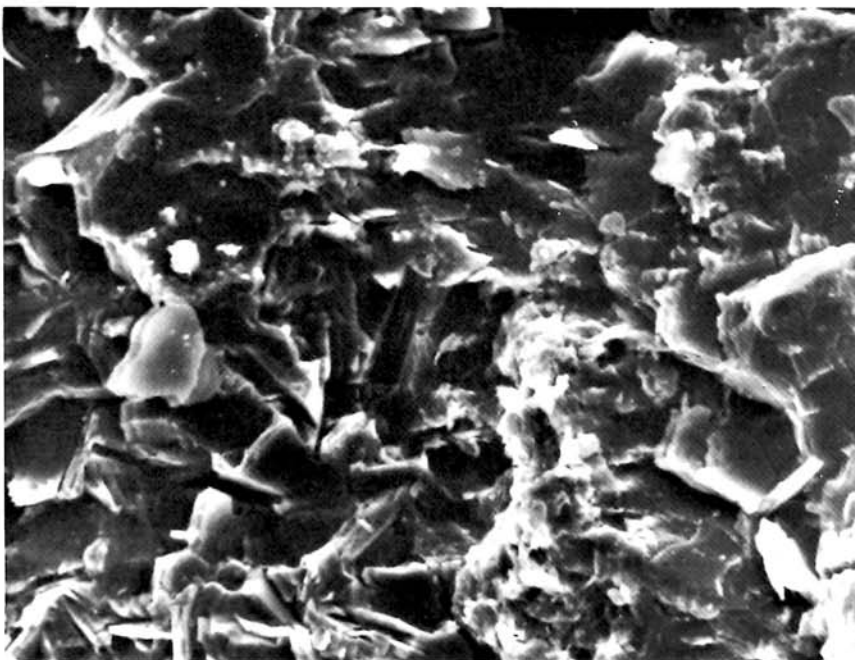


Scanning electron micrograph of the exposed surface of the Inscription of King Ram Khamhaeng.

King Ram Khamhaeng are similar to those on the other selected Sukhothai inscriptions. On each of these speci-

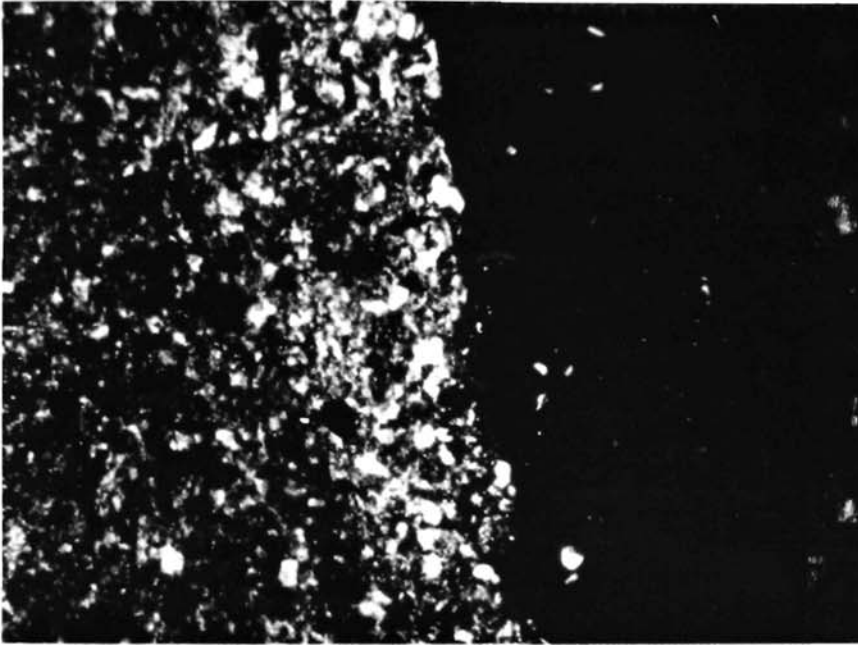
mens, calcite, the cementing material, and feldspar have gradually dissolved, leaving an eroded surface. The texture of the eroded surface is rough and full of cavities. Some minerals have been lost or altered.

Scanning electron micrograph of the unexposed surface of the Inscription of King Ram Khamhaeng.



Several spots on the specimens' surfaces, both exposed and unexposed parts, after analyzing by energy dispersive x-ray spectrometre shows a decrease or increase in the percentages of major elements and oxides on the exposed surfaces. The Inscription of King Ram Khamhaeng and other selected Sukhothai inscriptions show the same range of results. Generally the percentage of calcium (Ca) and calcium oxide (CaO) on the exposed surface are three to ten percent lower than those on the inner portion. The percentages of aluminium (Al) and alumina (Al_2O_3) on the exposed surface are two to ten percent lower than those on the inner portion. This indicates the dissolution of calcite and feldspar from the exposed surfaces.

exposed surface



Optical micrograph of a thin section of the exposed surface of the Inscription of King Ram Khamhaeng. It shows the calcite decreasing layer (pale area) caused by chemical weathering.

In addition, the thin sections of exposed surface of these inscriptions were carefully prepared and analysed by polarizing microscope. It was observed that the outermost layer of the exposed surfaces are apparently different from the inner layers. A layer of approximately 0.20-0.25 mm., where calcite disappeared or was remarkably reduced, is clearly visible on every specimen. It is quite obvious that these selected specimens are roughly contemporaneous.

A small fragment of one character on the third face of the Inscription of King Ram Khamhaeng was also examined by using the same technique. As a result, a decreasing calcite layer, of approximately 0.20-0.25 mm., was observed on the inscribed groove. This shows that the inscription was engraved shortly after surface polishing.

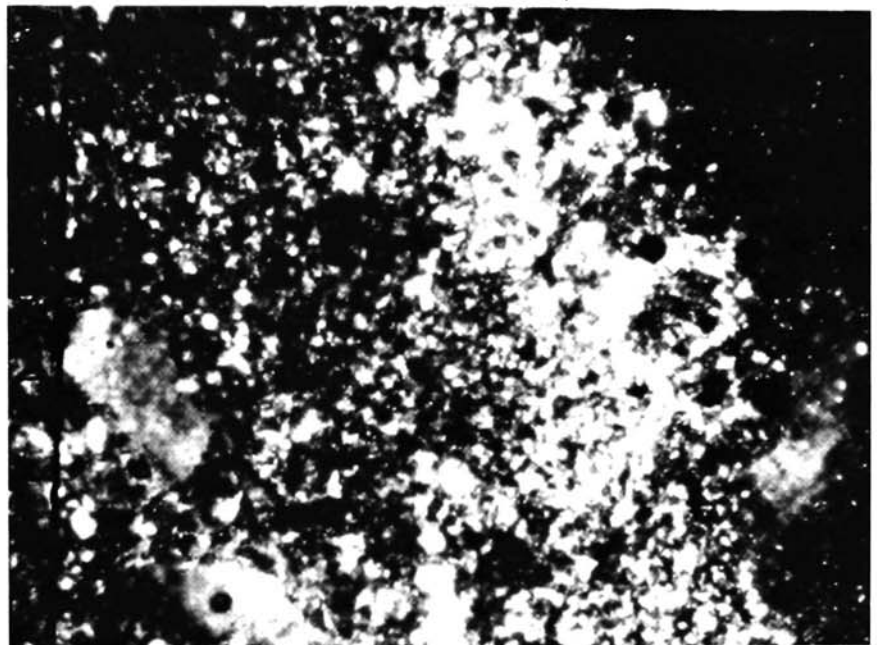
From this investigation, it seems unlikely that the Inscription of King Ram Khamhaeng was made in the early Bangkok Period. Although this investigation is unable to give the exact age of the inscription, it may be concluded here that this inscription could have been inscribed several hundreds years before 1833.

ACKNOWLEDGEMENT

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exposed surface



Optical micrograph of a thin section of a part of one character from the Inscription of King Ram Khamhaeng. It shows the calcite decreasing layer at the inscribed groove.